School Name: _____ Team Number: _____

2016 Purdue Science Olympiad Regional

It's About Time Exam

Division C

You will have 25 minutes to complete this exam. There are 29 questions for a total of 70 points. Points are allotted as noted. Many questions have partial credit, so be sure to show all relevant work.

You may use reference materials in a 3-ring-binder and a calculator that does not connect to the internet.

You may not consult other teams or use your phones at any time. You may split the test up, but be sure to write your school name on every page. Do not begin until instructed to do so. Good luck!

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1. What does UTC stand for? (1 pt)

2. In the USA, Eastern Standard Time is offset from UTC by how much? (answer format UTC±XX:XX) (1 pt)

3. In the USA, Pacific Standard Time is offset from UTC by how much? (answer format UTC±XX:XX) (1 pt)

4. Which has a higher frequency, microwaves or radio waves? (1 pt)

5. Which has a longer period, microwaves or x-rays? (1 pt)

6. Which has a shorter wavelength, red light or blue light? (1 pt)

7. What are Kepler's laws of planetary motion? (3 points)

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8. How many vibrations of a Cesium atom are in a second? (1 pt)

9. What causes leap seconds, and when are they added (2 pts)?

10. How long will it take for the NIST-F2 atomic clock to accrue 1 second of error? (1 pt)

11. What improvement was made to improve the accuracy from NIST-F1 to NIST-F2, and what source of error did it reduce? (2 pts)

12. If a 15 inch simple pendulum oscillates under earth surface gravity, what is the frequency and the period of the pendulum, in Hz and seconds? (4 points)

13. What fraction of a sample is left after 3 half lives? (1 pt)

14. A sample has a half life of 3.56 years. If the sample started with 67g, how much is left after 8.46 years? (5 pts)

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15. A sample of a substance begins with 129mg, and after decaying for 27.87 seconds there are 81mg remaining. What is the half-life of the substance? (5 pts)

16. The second harmonic of a string is 440 Hz. What are the frequencies of the first and third harmonics? (2 pts)

17. In the southern hemisphere, do shadows move across the face of an equatorial sundial in a clockwise or counter-clockwise fashion? (1 pt)

18. If you took the same picture of the sun at noon each day for a year, and then overlaid all the images, what shape would the different images of the sun form? What is the name of this feature? (2 pts)

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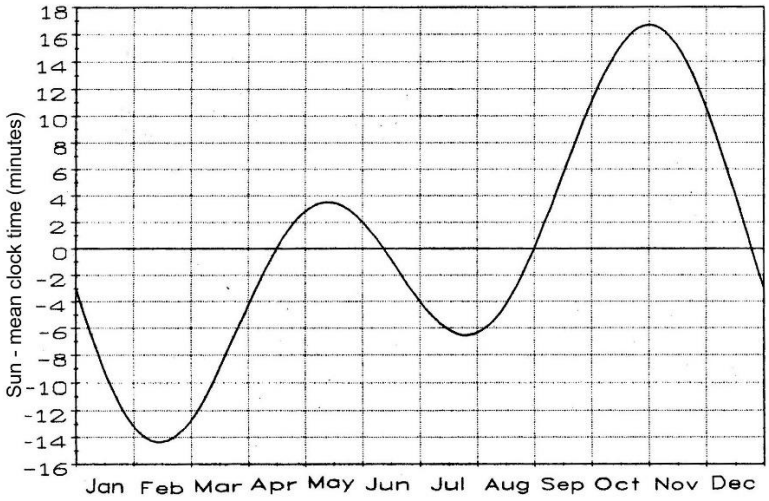
19. If it is the first of October, and a sundial reads 5:48 pm, what is the actual time? Use the Equation of Time shown in the graph below. (2 pts)



20. List a shortcoming of the sundial, and a shortcoming of water clocks. (2 pts)

21. Who invented the pendulum clock, and in what year? (2 pts)

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22. Why would an early model of the pendulum clock run faster in the winter than the summer? (2 pts)

23. Why is it important that the angle in a pendulum be kept to a minimum? (2 pts)

24. A flight leaves San Francisco (PDT) and travels 6900 miles to Hong Kong (UTC+8). If the plane averages 580mph, and takes off at 7:36pm (local time) on May 15, what is the local time to the nearest minute when the plane arrives in Hong Kong? (5 pts)

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25. A pendulum in simple harmonic motion has a maximum displacement of .2 radians and a length of 18cm. Time t = 0 occurs when there is maximum displacement. What is the equation for the displacement of the pendulum at any time t? (4 pts)

26. Which of the following are leap years? Circle all that apply. (4 pts)

    2000 2016 1900 1950

27. A planet of mass 7.38*10^23 kg orbits a star of mass 6.19*10^31kg. The average radius of the orbit is 4.2*10^9 km. How long does it take for the planet to complete 1 orbit? The answer should be in terms of earth years. (5 pts)

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28. What is a piezoelectricity and how is it used in timekeeping? (2 pts)

29. Two twins were born on the same day, but when they were 12 Twin 1 boarded a rocket travelling at 60% of the speed of light while Twin 2 stayed on Earth. Twin 1 spends 25 years on the rocket before returning to Earth. How old is Twin 2 when the rocket returns? (5 pts)